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IS 4025 (2006): Rolling bearings -Gauging practice [PGD 13: Bearing]



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भारतीय मानक
रोलिंग बेयरिंग — मापन रीति
(दूसरा पुनरीक्षण)

Indian Standard
ROLLING BEARINGS — GAUGING PRACTICE
(*Second Revision*)

ICS 21.100.20

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Bearings Sectional Committee had been approved by the Production and General Engineering Division Council.

This standard was first published in 1967. The following major changes were made in first revision:

- a) Tapered roller, needle roller and thrust bearings have been included;
- b) Recommended taper values for the test mandrel have been changed from 1/4 000 - 1/5 000 to 1/5 000 - 1/10 000;
- c) An additional method has been specified for measuring the radial run out of the inner and outer rings, covering the tapered roller and angular contact bearings;
- d) Method of measurement of the axial runout of the raceway with reference side of the inner ring has been changed; and
- e) Method of measurement of the axial runout of the raceway with reference side of the outer ring has been added.

In this standard following changes have been further made to update the standard:

- a) Relative humidity has been added.
- b) Purpose of applying measuring load during the inspection of radial internal clearance has been added.
- c) Measuring weight has been added for the width checking of tapered roller bearings, radial and axial run out checking of ball and tapered roller bearings and the side face run out with respect to bore.
- d) Measurement of tapered bore has been added.
- e) Diameter under rollers for cylindrical roller bearings added.

In the formulation of this standard, assistance has been derived from the following publications:

JIS B 1515-1975 'Methods of measurement for rolling bearings', issued by the Japanese Industrial Standards Committee.

ANSI B 3.4-1971 'Tolerance definitions and gauging practices for ball and roller bearings', issued by the American National Standards Institute.

Indian Standard

ROLLING BEARINGS — GAUGING PRACTICE

(Second Revision)

1 SCOPE

This standard covers methods for measurement of dimensional accuracy, running accuracy and radial internal clearance of rolling bearings.

1.1 Various gauging methods are in use to measure the dimensional and running accuracy of the bearings. The methods which commonly used by bearing users and manufacturers and which provide an accuracy sufficient for practical purposes have been covered.

2 REFERENCE

The following standard contains provisions which through reference in this text, constitutes provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
2984 : 2003/ ISO 3650 : 1998	Slip gauges — Specification (second revision)

3 GENERAL MEASURING CONDITIONS

3.1 Cleaning

Before starting the measurement, the bearings shall be thoroughly cleaned with white paraffin or mineral turpentine and dried.

3.2 Gauging Equipment

3.2.1 Slip Gauges (Gauge Blocks)

The slip gauges shall conform to IS 2984.

3.2.2 Indicators

The indicators shall be with suitable calibration and of appropriate sensitivity and accuracy corresponding

to the measuring conditions and the tolerance values for the bearings. Indicator selected shall have least count of approximately one-tenth of tolerance of parameter under measurement (0.001 or 0.01 mm as the case may be).

3.2.3 Tolerances of Mandrel

The radial run out of the tapered mandrels used for measuring the side run out of bore of radial run out of the bearings shall not exceed 2 μm and shall be made smaller corresponding to the tolerance values for the bearings. In case of measurement of higher precision class bearings, mandrels run-out to be less than 1 μm .

The tapered mandrels for cylindrical bore shall have taper between 1/5 000 and 1/10 000.

The basic taper of the mandrels for tapered bore shall be 1/12. Deviation from the basic taper shall be within $\pm 0.000\ 2$.

3.3 Measuring Temperature

Before starting the measurement, the part to be measured and the measuring equipment shall be brought to $20 \pm 1^\circ\text{C}$ temperature.

Relative humidity shall be maintained between 50 to 60 percent.

3.4 Reference Side

The reference side shall be as stipulated by the manufacturer.

3.5 Measuring Pressure and Radius of Gauge Tip

The measuring pressure and the radius of the gauge tip shall be such that steady measured values can be obtained and the elastic deformation is as small as possible.

Recommended values for the measuring pressure and the radius of the gauge tip, when measuring the bearing bore diameter and the outside diameter, are given below:

<i>Dimension</i>	<i>Nominal Value of the Dimension mm</i>	<i>Measuring Pressure, Max, N</i>	<i>Radius of Gauge Tip Min, mm</i>
Bearing bore diameter	Over 2.5 up to and including 10	2.0	0.8
	Over 10 up to and including 30	2.0	2.5
	Over 30	3.0	2.5
Bearing outside diameter	Over 6 up to and including 30	0.5	2.5
	Over 30	2.0	2.5

3.6 Measuring Load for Running Accuracy

The measuring load for running accuracy shall be such that repetitive readings are obtained without play between the steel balls or rollers and the raceways. Care shall be taken while applying the load to ensure that no deformation of the rolling elements or the track takes place.

3.7 Measuring Load for Radial Internal Clearance

The measuring load for radial internal clearance shall be of such magnitude as to permit obtaining steady readings. As the clearance is measured by applying a radial load the measured clearance for ball bearings is always slightly larger than the actual internal clearances due to the elastic deformation caused by measuring load. The actual internal clearance may be obtained by correcting the measured clearance to the amount of elastic deformation. Measuring load and the increase of clearance due to the load is given below:

Over	Including	Measuring Load	RC Increase for Ball Bearings, in microns			
			C2	Normal	C3	C4
10	18	24.5 N (2.5 kg)	3 to 4	4	4	4
18	50	49 N (5 kg)	4 to 5	5	6	6
50	100	147 N (15 kg)	6 to 8	8	9	9

4 DIMENSIONAL ACCURACY

4.1 Inner Ring

4.1.0 The methods described are applicable to all types of rolling bearings.

4.1.1 Bearing Bore Diameter

For measuring the single inside diameter d of the bearing use a 2-point gauge. The two measuring points shall be on a plane perpendicular to the axis of the bearing and opposite to each other.

If the maximum and minimum single diameter readings are d_{Max} and d_{Min} respectively, the mean inside diameter d_m is given by the following formula:

$$d_m = \frac{d_{Max} + d_{Min}}{2}$$

If the size or section of the inner ring is such that with the bearing axis in a horizontal position the bore measurement is influenced by gravity or measuring load, or both, by more than 10 percent of the bore diameter tolerance, the bearing shall be placed with the axis in a vertical position and if necessary a lower measuring load used (see Fig. 1).

4.1.2 Width and Width Variation

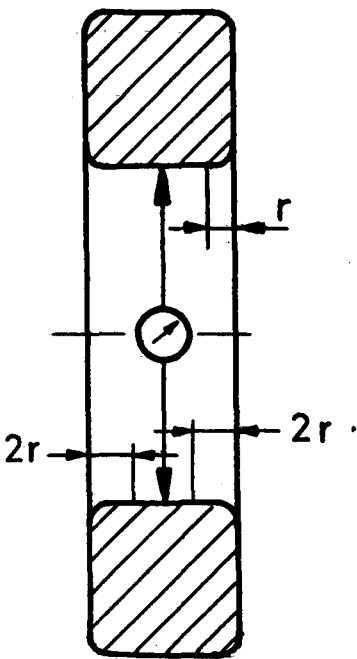
Keeping the outer ring free, support one side of the inner ring on 3 supporting points. The movement of the stylus shall be perpendicular to the reference plane passing through the supporting points. Apply an indicator to the other side directly above one supporting point. The width variation of an individual ring is the difference between the maximum and the minimum readings taken while rotating the outer ring for one complete revolution (see Fig. 2).

4.2 Outer Ring

4.2.0 The methods described are applicable to all types of rolling bearings.

4.2.1 Bearing Outside Diameter

The outside single diameter D of the bearing shall be measured between a flat surface and the mounted end



NOTE — Measurement of bore diameter to be away from either faces of ring by $2r$, where r is coordinate of corner radius in axial direction.

FIG. 1

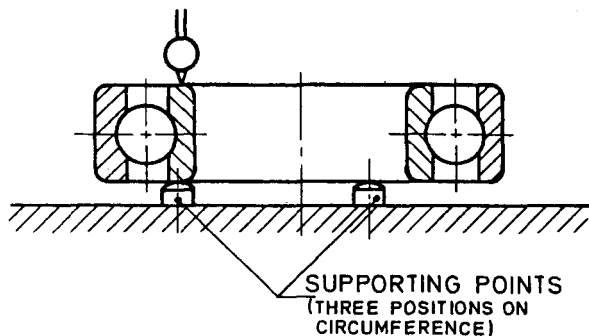
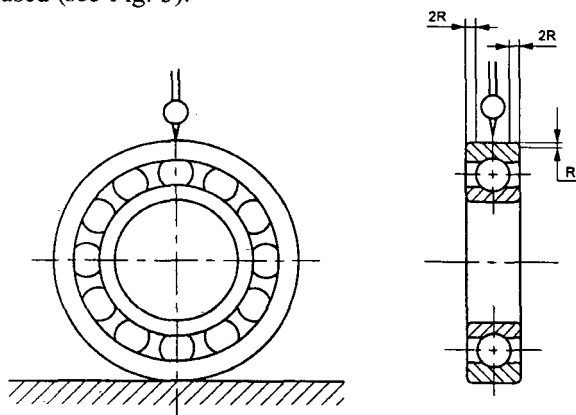


FIG. 2

of an indicator. If the maximum and minimum single diameter readings are D_{Max} and D_{Min} respectively, the mean outside diameter D_m is given by the following formula:

$$D_m = \frac{D_{\text{Max}} + D_{\text{Min}}}{2}$$

If the size or section of the bearing outer ring is such that with the bearing axis in horizontal position the outside diameter measurement is influenced by gravity or measuring load or both, by more than 10 percent of the outside diameter tolerance, the bearing shall be placed with the axis in a vertical position and, if necessary, the lower measuring load used (see Fig. 3).



NOTE — Measurement of outer diameter of outer ring to be away from either side faces of ring by $2R$ where R is coordinate of corner radius, on outer diameter, in axial direction.

FIG. 3

4.2.2 Width and Width Variation

Keeping the inner ring free, support one side of the outer ring on 3 supporting points. The movement of the stylus shall be perpendicular to the reference plane passing through the supporting points. Apply an indicator to the other side directly above one supporting point. The width variation of an individual ring is the difference between the maximum and the minimum readings taken while rotating the outer ring for one complete revolution (see Fig. 4).

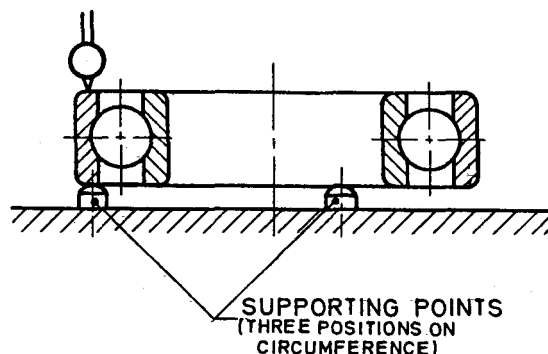


FIG. 4

4.3 Total Bearing Width of Tapered Roller Bearings

Apply an indicator in axial direction over the test weight placed on the outer ring's back face, placing the inner ring back face on a plane and keeping the rolling elements and the bearing rings in stable contact. Carry out the measurements at several approximately equiangular positions. The bearing width is given by the arithmetical mean of these measured values (see Fig. 5).

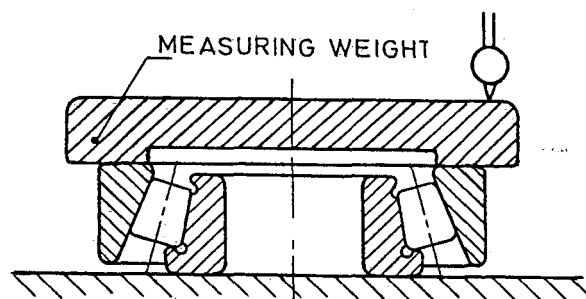


FIG. 5

4.4 Height of Thrust Ball Bearings with Flat Seat

Apply an indicator in axial direction to the shaft washer back face in the case of single direction thrust ball bearing and to the other housing washer back face in the case of double direction thrust ball bearing, placing the back face of the outer ring on the flat surface and keeping the rolling elements and the raceway tracks in position. Carry out the measurements at several approximately equiangular positions. The bearing height is given by the arithmetical mean of these measured values (see Fig. 6A and 6B).

5 RUNNING ACCURACY

5.1 Inner Ring and Outer Ring

5.1.1 Radial Run Out

5.1.1.1 Method 1

This method is applicable to cylindrical and needle roller bearings. Mount the bearing on a test mandrel and load the mandrel between 2 accurate centres or

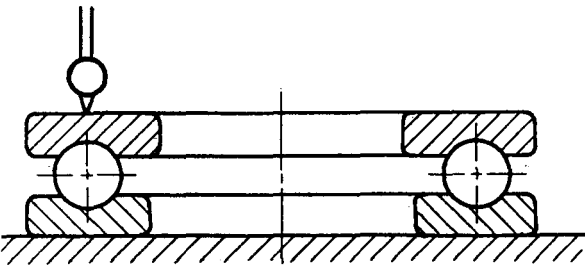


FIG. 6A

suitable supports in such a way that it can be rotated. Apply an indicator to the middle of the width of stationary outer ring. The radial run out of inner ring is the difference between the maximum and minimum readings taken while rotating the mandrel for one complete revolution. Similarly rotate the outer ring for outer ring radial run out keeping the inner ring stationary (see Fig. 7).

5.1.1.2 Method 2

This method is applicable to single row deep groove ball bearings, single row angular contact ball bearings and tapered roller bearings.

Support the outer ring and apply a uniform coaxial load to the reference side or the thrust side of the outer ring to ensure contact between the rolling

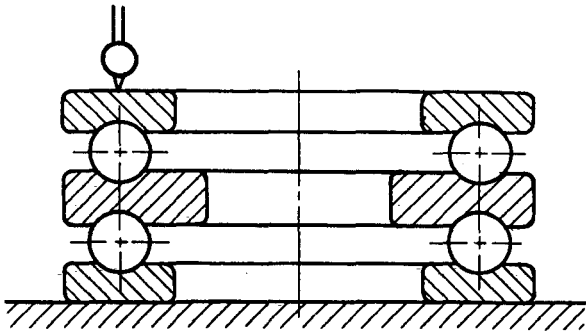


FIG. 6B

total indicator reading is the outer ring radial run out (see Fig. 8).

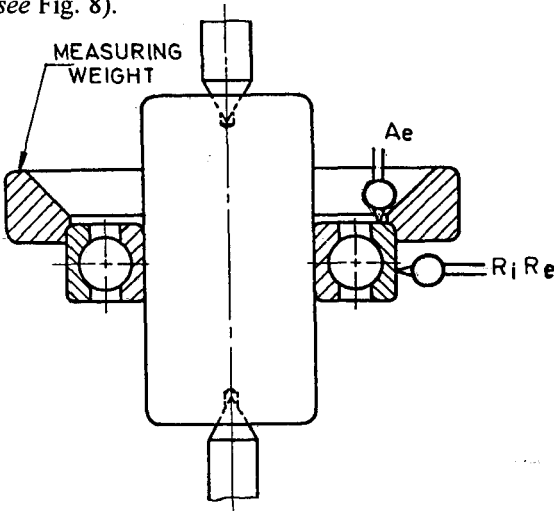


FIG. 8A

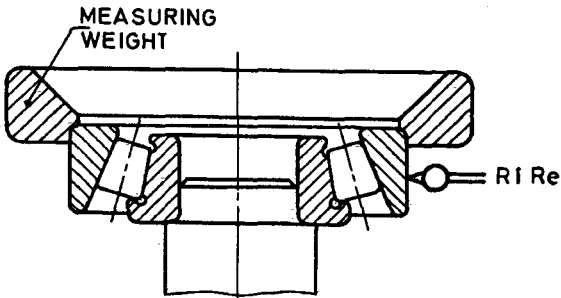
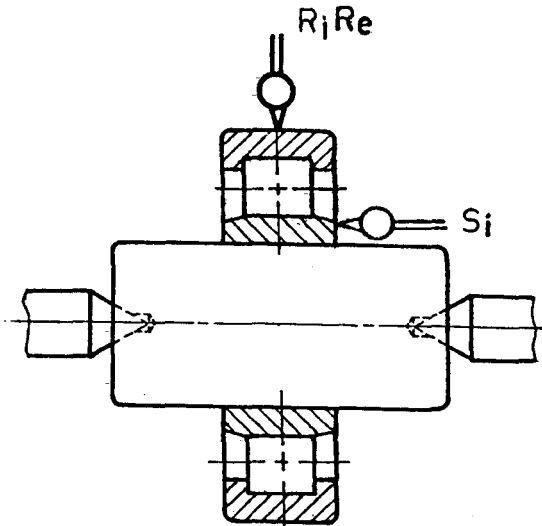


FIG. 8B



- R_i = rotate inner ring with outer ring stationary
- R_o = rotate outer ring with inner ring stationary
- S_i = rotate inner ring with outer ring

FIG. 7

elements and raceways. Apply an indicator to the centre of the outer ring outside diameter. The radial run out of inner ring is the total indicator reading taken while rotating the mandrel for one complete revolution keeping the outer ring stationary. Similarly, keeping the mandrel stationary, rotate the outer ring and the

5.1.2 Axial Run Out and Face Run Out with Reference to Raceway

Mount the bearing on a test mandrel and apply a uniform coaxial load and load the mandrel between two centres in such a way that it can be rotated. Apply an indicator on the top face of the outer ring. Axial run out/side face run out is the total indicator reading for one complete revolution of outer ring, when inner ring is kept stationary. Similarly, rotate the mandrel for one complete revolution keeping the outer ring stationary to obtain the inner ring axial run out (see Fig. 9, 10A, and 10B) side face run out with respect to raceway.

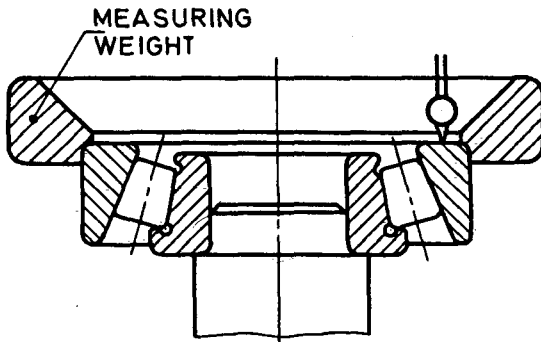


FIG. 9

5.1.3 Side Face Run Out of Inner Ring with Reference to Bore

Mount the bearing on a test mandrel and load the mandrel between two accurate centres, in such a way that it can be rotated. Apply an indicator on the side face of inner ring (large face in case of TRB). Rotate the mandrel for one complete revolution, keeping the outer ring stationary. The total indicator reading is the side face run out of inner ring with respect to bore (see ' S_i ' in Fig. 7, Fig. 10A and 10B).

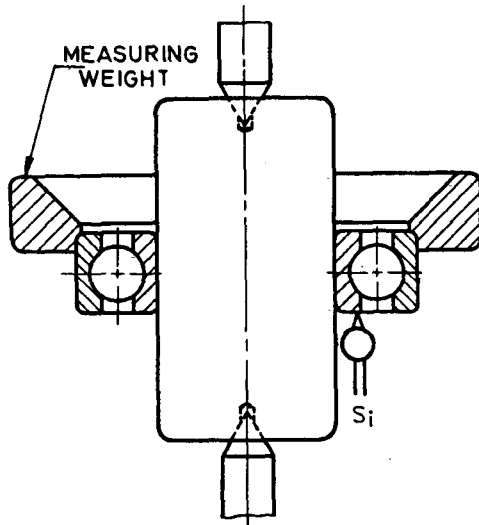


FIG. 10A

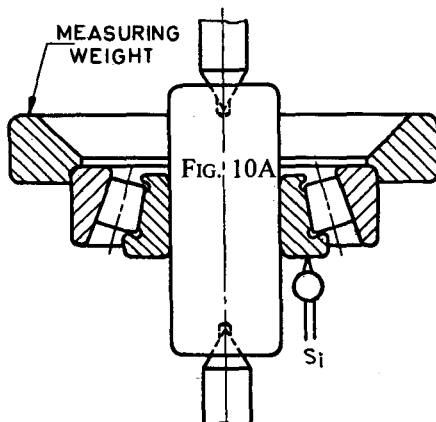


FIG. 10B

S = rotate inner ring with outer ring stationary

5.2 Outside Cylindrical Surface Run Out with Reference Side

Keeping the inner ring free, support the reference side of the outer ring on a flat serrated plate and hold against a stop located near the lower corner of the outside surface. Apply an indicator directly above the stop close to the upper corner of the outside surface. The run out is the difference between the maximum and the minimum readings taken while rotating the outer ring for one complete revolution (see Fig. 11).

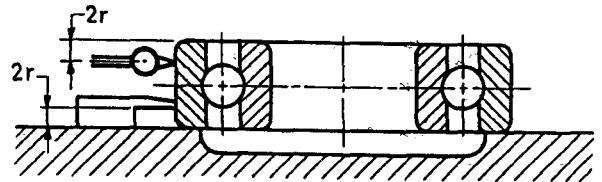


FIG. 11

5.3 Raceway Run Out with Side of Thrust Ball Bearings with Flat Seat

5.3.1 Raceway Run Out with Side of the Shaft Washer and Centre Shaft Washer

Apply an indicator in axial direction to the bottom of the raceway groove directly above the supporting point set on a plane of the guide stops, supporting the back face of the shaft washer on three supporting points set on a plane and pressing the shaft washer bore to two guide stops set on the plane. The raceway run out with side of the shaft washer is the difference between the maximum and the minimum readings taken while rotating the shaft washer for one complete revolution, guiding with the guide stops (see Fig. 12).

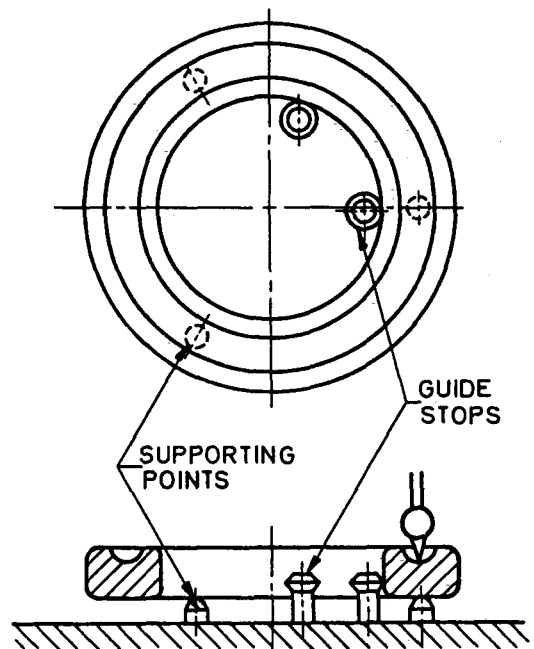


FIG. 12

For centre shaft washers of double direction thrust ball bearings, measurements shall be carried out for both the raceway grooves in the same way as for shaft washers of single direction bearings, the inner part of the side face of the washer being supported on the supporting points (see Fig. 13).

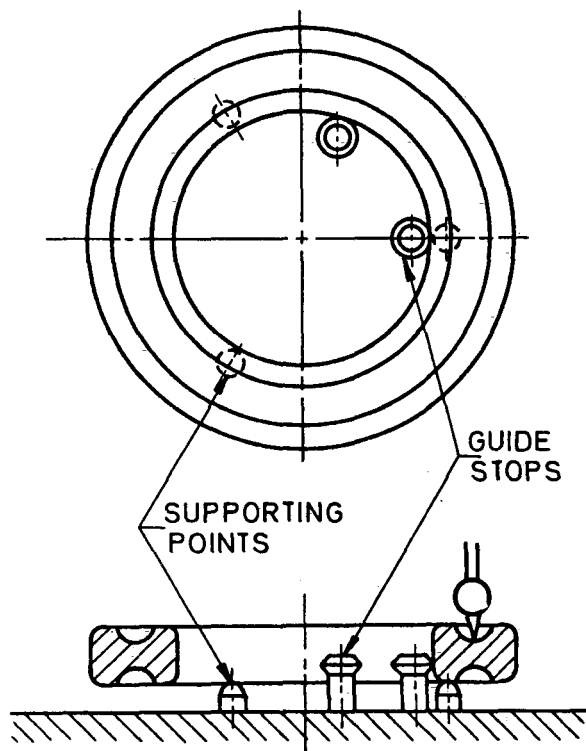


FIG. 13

5.3.2 Raceway Run Out with Side of Housing Washer

Apply an indicator in axial direction to the bottom of the raceway groove directly above the supporting point nearest to one of the guide stops, supporting the back face of the housing washer on three supporting points set on a plane and pressing the outside surface of the housing washer to two guide stops set on the plane. The raceway run out with side of the housing washer is the difference between the maximum and the minimum readings taken while rotating the housing washer for one complete revolution, guiding it with the guide stops (see Fig. 14).

6 RADIAL INTERNAL CLEARANCE

Fix the inner ring of the bearing to be measured on a flat plate with shims between the ring and the plate. Apply radially the measuring load specified in 3.7 to the unfixed ring alternately in directions A and B. While taking the measurements, care shall be taken to ensure contact between the

respective raceway and the rolling elements. The value of the radial clearance is the arithmetical mean of the unfixed ring in the direction of the measuring load at various angular positions of the ring and the rolling elements in relation to each other (see Fig. 15).

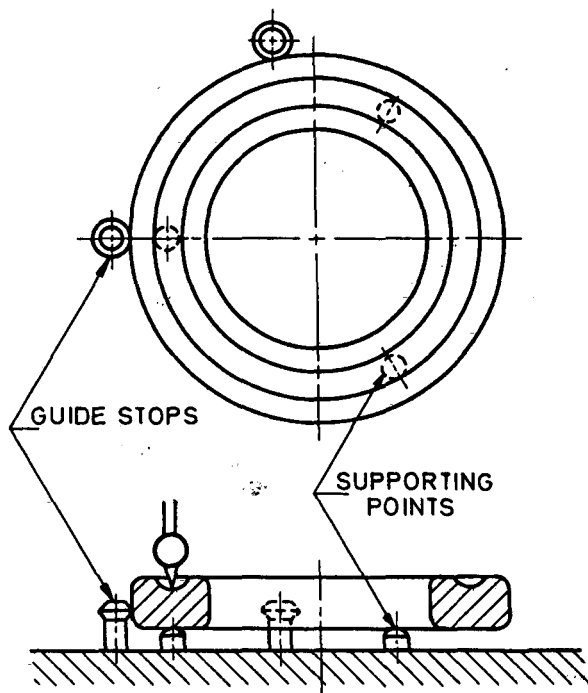
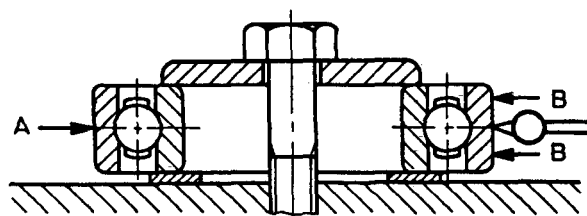


FIG. 14



NOTE — Shim thickness to be as low as possible (around 0.1 mm thick) to avoid twist during measurement.

FIG. 15

7 BORE DIAMETER (d) AND TAPER OF TAPERED BORE BEARINGS

Normally apparatus arranged for two point measurement is used. Measure the diameters d , d_b and d_a . Then, place the bearing on the table with the small bore side down and measure the distances h_a and h_b (see Fig. 16).

Taper θ and bore diameter (d) can be calculated with the following formula:

$$\text{Taper measurement } (\theta) = \tan^{-1} \frac{d_a - d_b}{2(h_a - h_b)}$$

$$\text{Bore dia } (d) = \frac{h_b \cdot d_a - h_a \cdot d_b}{h_b - h_a}$$

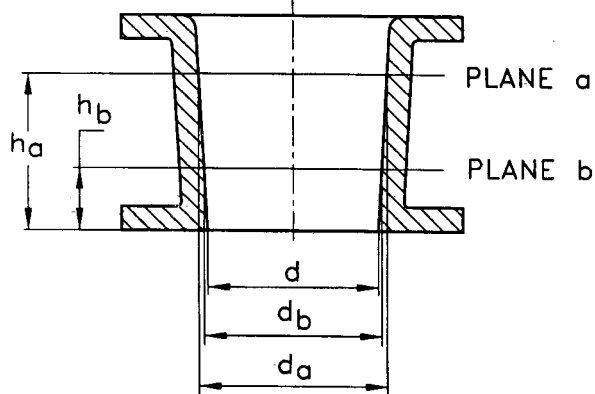


FIG. 16

8 DIAMETERS UNDER ROLLERS (INSCRIBED CIRCLE DIAMETER 'dr') FOR NUS/RNU TYPE CYLINDRICAL ROLLER BEARINGS

Normally, a master plug gauge is used. Fix the master

ring gauge or plug gauge alongside the roller complement on a horizontal or vertical plane. Apply the indicator to the outer ring outside diameter at the centre of the width in radial direction. Apply sufficient radial load alternately on the outer ring in the same radial direction as that of the indicator and record the total indicator reading. By adding or subtracting this reading to the plug gauge, diameter d_r can be obtained (see Fig. 17).

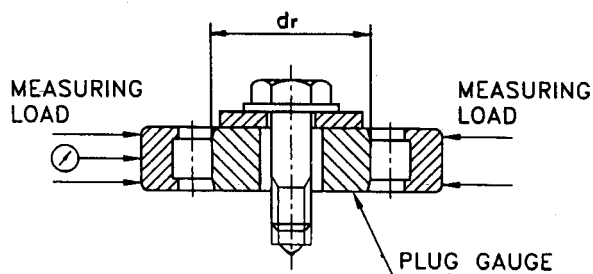


FIG. 17

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Amendments Issued Since Publication

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